REMARKS

Claim Rejections 35 U.S.C. § 103 (a)

Claims 1, 4-12, 18, 20, 25, and 27-31

The Examiner has rejected claims 1, 4-12, 18, 20, 25, and 27-31 under 35 U.S.C. §103 (a) as being unpatentable over Casey, Jr. et al. (US 6,042,738) as demonstrated by Baum, Aaron Wolf et al. (US 5,684,360 A) in view of Parker, Norman W. et al. (US 4,818,872 A).

Applicants respectfully disagree with the Examiner. Applicants have amended claims 1, 25, and 31.

Claim 1, as amended, of Applicants' claimed invention, claims an apparatus (400) apparatus including: a holder (420) to mount a substrate (410); a stage (430) located below the holder; an imaging system (440) located vertically above an opaque defect on the substrate; a gas delivery system (450) including a nozzle with a diameter of 100-300 microns located over the opaque defect (405) at a tilt angle of 45-70 degrees from vertical, a distance of 50-150 microns, and an angular dispersion of 5-25 degrees to dispense a reactant gas and a carrier gas from a reservoir; and an electron scanning delivery system (460) located over the opaque defect to direct electrons in a range of 0.3-3.0 keV towards the reactant gas wherein the electron beam has a tail diameter of 5-125 nanometers. See Figure 4. Also, see pages 10-12 of the specification.

Claim 25, as amended, of Applicants' claimed invention, claims an apparatus (400) for repairing an opaque defect (405) on a mask (410) without ion implantation or knock-on of atoms comprising: a chamber (470); a stage (430) disposed in said chamber; a holder (420) disposed over said stage; a mask disposed over said holder;

an opaque defect disposed on said mask; an imaging system (440) disposed directly above said opaque defect; a gas delivery system (450) disposed at a first angle over said opaque defect; an electron scanning delivery system (460) disposed at a second angle over said opaque defect; electrons disposed over said opaque defect, wherein said electrons interact with a gas that is adsorbed and dissociated on said opaque defect without damaging underlying layers; and a pumping system disposed in said chamber to evacuate volatile byproducts. See Figure 4. Also, see pages 10-12 of the specification.

Claim 31, as amended, of Applicants' claimed invention, claims a mask repair system (400) including: a chamber (470), said chamber to hold a mask (410); an imaging system (440) disposed in said chamber to locate an opaque defect (405) on said mask; a gas delivery system (450) disposed in said chamber, to dispense one or more gases from reservoirs through nozzles towards said opaque defect; and an electron scanning delivery system (460) disposed in said chamber to provide a highly focused beam of electrons with an electron beam size smaller than 30% of smallest critical defect to interact with said one or more gases adsorbed and dissociated over said opaque defect. See Figure 4. Also, see pages 10-12 of the specification.

Despite the assertions of the Examiner, the apparatus taught by the three cited references are not compatible. No motivation to combine has been shown in the references themselves by the Examiner. Therefore, it is improper for the Examiner to use hindsight to combine the apparatus taught by the three cited references.

Applicants' claimed invention uses electron optics to accelerate electrons in an electron beam and focus the electrons onto a gas dispensed over an opaque defect on a substrate, such as a mask. In an embodiment of Applicants' claimed invention, the gas adsorbs to the opaque defect and becomes dissociated. See lines 26-28 on page 12 of the specification.

In contrast, Casey et al. teaches a focused particle beam system (10) where the term **particle beam** encompasses ion beams, electron beams, neutral particle beams,

x-ray beams, and any other radiation **suitable for imaging or etching** a workpiece. See col. 3, lines 66-67 and lines 8-14. Also, see Figure 1.

Applicants wish to bring to the attention of the Examiner that the electrons in Applicants' claimed invention are **not** used for imaging and are **not** used for etching.

Furthermore, Casey et al. clearly teaches that the **focused particle beam** is used to **precisely mill** a workpiece having an opaque film patterned on a substrate. See col. 4, lines 4-7. Also, see Figure 1.

Applicants wish to bring to the attention of the Examiner that the electrons in Applicants' claimed invention are **not** used to mill the workpiece, whether precisely or otherwise.

In particular, Casey et al. teaches a focused ion beam (FIB) system in which ions from **directly above** the workpiece are focused and accelerated **straight down** to mill a surface of the workpiece.

Applicants wish to bring to the attention of the Examiner that the electrons in Applicants' claimed invention are directed at an **angle** towards a **gas**. The induced etch as claimed by Applicants is a **chemical process** so the electrons are **not** directed straight at the workpiece, unlike for a **physical process** such as sputtering or milling as claimed by Casey et al.

Casey et al. teaches a typical beam spot size between approximately 0.7 microns and 0.2 microns. See col. 6, lines 5-6. Such a range of spot sizes corresponds to a dimension of about 200-700 nanometers.

Applicants claim an electron delivery system (460) that provides a **highly focused electron beam**. In one embodiment, tightly focused means that the electron beam size is amaller than the range of the secondary electrons. In another embodiment, highly focused means that the electron beam size is smaller than about 30% of the size of the smallest critical defect to be repaired. In general, the electron beam of Applicants' claimed invention has a typical tail diameter of about 5-125 nm. See lines 1-8 on page 14 of the specification. Also, see Figure 4.

Baum et al. teaches an electron source that includes a negative electron affinity (NEA) photocathode (10) on a light-transmissive substrate (12) and a light

beam generator (20) that includes a light source (50) and optical elements (52) to focus and to direct a light beam (22) through the light-transmissive substrate at the photocathode for exciting electrons at an active emission area (26) to the conduction band of the photocathode to emit electrons into a vacuum to be formed by electron optics (32) into an electron beam (30). See Col. 3, lines 29-46. Also, see Figures 1-2. .

The light source may have a wavelength of about 300-800 nanometers. The photocathode is typically formed from a semiconductor material, such as from Group IV of the periodic table or a compound from Group III and Group V, with a heavy p-doping and application of an activation layer to lower the work function.

However, such a photocathode cannot provide the high brightness and small spot size necessary for mask repair as envisioned by Applicants' claimed invention. For example, Baum et al. teaches a spot size of about 2-100 microns whereas Applicants envision a spot size of about 0.005-0.125 micron.

Parker et al. teaches a charge neutralization mode in which an electron gun (4) floods a non-conducting target with low energy electrons (0-550 eV) having a perpendicular incidence to the surface of the target. A 90-degree spherical electrostatic capacitor (20) (with variable voltages on both the inner and outer electrodes) is used as an energy analyzer (44) to steer and deflect an electron beam (10) from a horizontal direction to a vertical direction to accomplish a charge neutralization that is optimized in both direction and energy.

Alternatively, Parker et al. teaches an imaging mode in which secondary ions (SI) or secondary electrons (SE) emitted from the target surface due to bombardment by a primary ion (PI) beam may be efficiently collected through a large solid angle using the same circular entrance aperture (16) (from which the primary ion beam emerges) to form an image.

Furthermore, Parker et al. also teaches a SIMS mode in which secondary ions (SI) or secondary electrons (SE) emitted from the target surface due to bombardment by a primary ion (PI) beam may be efficiently collected through a large solid angle using the same circular entrance aperture (16) (from which the primary ion beam emerges) to produce mass spectra depth profiles, or elemental maps of the target.

Again, such an electron flood will fail to produce a beam that is bright enough and small enough for mask repair as envisioned in Applicants' invention.

Combination of the three references cited by the Examiner, even if possible, would still not produce the apparatus of Applicants' claimed invention, as claimed in claims 1, 25, or 31. Consequently, Applicants' claimed invention, as claimed in claims 1, 25, or 31, would not have been obvious to one of ordinary skill in the art of fabricating semiconductors at the time the invention was made.

Claims 4-12, 18, and 20 are dependent on claim 1. Claims 27-30 are dependent on claim 25. Since combination of the three cited references, even if possible, would still not produce the apparatus as claimed in claim 1 or 25, of Applicants' claimed invention, the apparatus claimed in claims 4-12, 18, 20, and 27-30 of Applicants' claimed invention would also not have been obvious to one of ordinary skill in the art of semiconductors at the time the invention was made.

In view of the foregoing, Applicants respectfully request the Examiner to withdraw the rejections to claims 1, 4-12, 18, 20, 25, and 27-31 under 35 U.S.C. §103 (a).

Claim 19

The Examiner has rejected claim 19 under 35 U.S.C. §103 (a) as being unpatentable over Casey, Jr. et al. (US 6,042,738) as demonstrated by Baum, Aaron Wolf et al. (US 5,684,360 A) in view of Parker, Norman W. et al. (US 4,818,872 A) and Fuji, Eiji etal. (US 5,876,504 A).

Applicants respectfully disagree with the Examiner. Claim 19 is dependent on claim 1. Applicants have amended claim 1.

Claim 1, as amended, of Applicants' claimed invention, claims an apparatus (400) apparatus including: a holder (420) to mount a substrate (410); a stage (430) located below the holder; an imaging system (440) located vertically above an opaque defect

on the substrate; a gas delivery system (450) including a nozzle with a diameter of 100-300 microns located over the opaque defect (405) at a tilt angle of 45-70 degrees from vertical, a distance of 50-150 microns, and an angular dispersion of 5-25 degrees to dispense a reactant gas and a carrier gas from a reservoir; and an electron scanning delivery system (460) located over the opaque defect to direct electrons in a range of 0.3-3.0 keV towards the reactant gas wherein the electron beam has a tail diameter of 5-125 nanometers. See Figure 4. Also, see pages 10-12 of the specification.

As discussed in an earlier section, the Examiner has shown no motivation within the references themselves to combine. Furthermore, combination of the four references cited by the Examiner, even if possible, would still not produce the apparatus of Applicants' claimed invention, as claimed in claim 1. Consequently, Applicants' claimed invention, as claimed in claim 1, would not have been obvious to one of ordinary skill in the art of fabricating semiconductors at the time the invention was made.

Claim 19 is dependent on claim 1. Since combination of the four cited references, even if possible, would still not produce the apparatus as claimed in claim 1 of Applicants' claimed invention, the apparatus claimed in claim 19 of Applicants' claimed invention would also not have been obvious to one of ordinary skill in the art of semiconductors at the time the invention was made.

In view of the foregoing, Applicants respectfully request the Examiner to withdraw the rejections to claim 19 under 35 U.S.C. §103 (a).

Claims 21-24, 26, and 32-33

The Examiner has rejected claims 21-24, 26, and 32-33 under 35 U.S.C. §103 (a) as being unpatentable over Casey, Jr. et al. (US 6,042,738) as demonstrated by Baum,

Aaron Wolf et al. (US 5,684,360 A) in view of Parker, Norman W. et al. (US 4,818,872 A).

Applicants respectfully disagree with the Examiner. Claims 21-24 are dependent n claim 1. Claim 26 is dependent on claim 25. Claims 32-33 are dependent on claim 31. Applicants have amended claims 1, 22-25, and 31.

Claim 1, as amended, of Applicants' claimed invention, claims an apparatus (400) apparatus including: a holder (420) to mount a substrate (410); a stage (430) located below the holder; an imaging system (440) located vertically above an opaque defect on the substrate; a gas delivery system (450) including a nozzle with a diameter of 100-300 microns located over the opaque defect (405) at a tilt angle of 45-70 degrees from vertical, a distance of 50-150 microns, and an angular dispersion of 5-25 degrees to dispense a reactant gas and a carrier gas from a reservoir; and an electron scanning delivery system (460) located over the opaque defect to direct electrons in a range of 0.3-3.0 keV towards the reactant gas wherein the electron beam has a tail diameter of 5-125 nanometers. See Figure 4. Also, see pages 10-12 of the specification.

Claim 25, as amended, of Applicants' claimed invention, claims an apparatus (400) for repairing an opaque defect (405) on a mask (410) without ion implantation or knock-on of atoms comprising: a chamber (470); a stage (430) disposed in said chamber; a holder (420) disposed over said stage; a mask disposed over said holder; an opaque defect disposed on said mask; an imaging system (440) disposed directly above said opaque defect; a gas delivery system (450) disposed at a first angle over said opaque defect; an electron scanning delivery system (460) disposed at a second angle over said opaque defect; electrons disposed over said opaque defect, wherein said electrons interact with a gas that is adsorbed and dissociated on said opaque defect without damaging underlying layers; and a pumping system disposed in said chamber to evacuate volatile byproducts. See Figure 4. Also, see pages 10-12 of the specification.

Claim 31, as amended, of Applicants' claimed invention, claims a mask repair system (400) including: a chamber (470), said chamber to hold a mask (410); an

imaging system (440) disposed in said chamber to locate an opaque defect (405) on said mask; a gas delivery system (450) disposed in said chamber, to dispense one or more gases from reservoirs through nozzles towards said opaque defect; and an electron scanning delivery system (460) disposed in said chamber to provide a highly focused beam of electrons with an electron beam size smaller than 30% of smallest critical defect to interact with said one or more gases adsorbed and dissociated over said opaque defect. See Figure 4. Also, see pages 10-12 of the specification.

As discussed in an earlier section, the Examiner has shown no motivation within the references themselves to combine. Furthermore, combination of the three references cited by the Examiner, even if possible, would still not produce the apparatus of Applicants' claimed invention, as claimed in claims 1, 25, or 31. Consequently, Applicants' claimed invention, as claimed in claims 1, 25, or 31, would not have been obvious to one of ordinary skill in the art of fabricating semiconductors at the time the invention was made.

Claims 21-24 are dependent on claim 1. Claim 26 is dependent on claim 25. Claims 32-33 are dependent on claim 31. Since combination of the three cited references, even if possible, would still not produce the apparatus as claimed in claims 1, 25, or 31 of Applicants' claimed invention, the apparatus claimed in claims 21-24, 26, and 32-33 of Applicants' claimed invention would also not have been obvious to one of ordinary skill in the art of semiconductors at the time the invention was made.

In view of the foregoing, Applicants respectfully request the Examiner to withdraw the rejections to claims 21-24, 26, and 32-33 under 35 U.S.C. §103 (a) under 35 U.S.C. §103 (a).

Conclusion

Applicants believe that all claims pending, including claims 1, 4-12, and 18-33, are now in condition for allowance so such action is earnestly solicited at the earliest possible date.

Pursuant to 37 C.F.R. 1.136 (a) (3), Applicant hereby requests and authorizes the U.S. Patent and Trademark Office to treat any concurrent or future reply that requires a petition for extension of time as incorporating a petition for extension of time for the appropriate length of time.

Should there be any additional charge or fee, including a Request for Continued Examination, an extension of time fee, or other fees under 37 C.F.R. 1.16 and 1.17, please charge Deposit Account No. 50-0221.

If a telephone interview would in any way expedite the prosecution of this application, the Examiner is invited to contact the undersigned at (408) 653-7897.

Respectfully submitted,
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